

# Milk Production During the Complete Lactation of Dairy Cows Fed Diets Containing Different Amounts of Protein

Z. Wu and L.D. Satter

## Introduction

The increase in milk production following incremental additions of protein to the dairy cow diet is a diminishing response, and the point of maximum profitability is likely to be at a dietary protein level that is slightly below that needed for maximum milk production. The objective of this study was to determine milk production response in high producing cows to dietary supplementation of different amounts of protein having low rumen degradability.

## Materials and Methods

Fifty-eight multiparous Holstein cows were used in a 44 wk lactation trial. Diets (Table 1) containing 15.4, 17.4 or 19.3% CP were fed during weeks 1 through 16 of lactation to groups of 15, 29 or 14 cows, respectively. Beginning at week 17 of lactation, cows were changed to diets that were fed for the remainder of lactation. Cows that were on the diet with 15.4% CP during the first 16 weeks were kept on a low protein diet (16.0% CP) for the rest of the lactation. Fourteen of the 29 cows fed the 17.4% diet in early lactation were kept at a similar level of protein (17.9% CP) for the rest of lactation, while the remaining 15 cows in that group were fed the 16.0% CP diet. Cows receiving the 19.3% CP diet in early lactation were switched to the 17.9% CP diet at week 17. Thus, the following four treatments were formed over the entire lactation with respect to dietary CP percentages: 15.4 @ 16.0, 17.4 @ 16.0, 17.4 @ 17.9, and 19.3 @ 17.9, with the change occurring at the beginning of week 17. Higher than expected protein content of alfalfa silage fed in the last 28 weeks of lactation resulted in small increases in total dietary protein for this phase of lactation.

## Results and Discussion

Milk yield for the 44 week lactation for the 17.4 - 16.0% CP treatment (10,832kg) was 776 kg higher ( $P < 0.12$ ) than that for the 15.4 - 16.0% CP

treatment (10,056 kg), and similar to the yields of 11,095 kg and 11,132 kg for the 17.4 - 17.9 and 19.3 - 17.9% CP treatments (Table 2 and Fig. 1). The amount of excreted N, estimated from intake N minus milk N (assuming no net change in tissue N), largely reflected N intake. The efficiencies for converting feed N to milk N, ranging from the lowest to the highest dietary protein treatments, were 28.8, 25.9, 24.1 and 24.7%. Means for dry matter intake did not differ ( $P < 0.05$ ) among dietary protein levels for weeks 1-16 of lactation, but may have been slightly higher for the two high treatments for weeks 17-44 of lactation. Dry matter intake for the lowest protein group was often less than for the other treatments for the first 31 weeks of lactation.

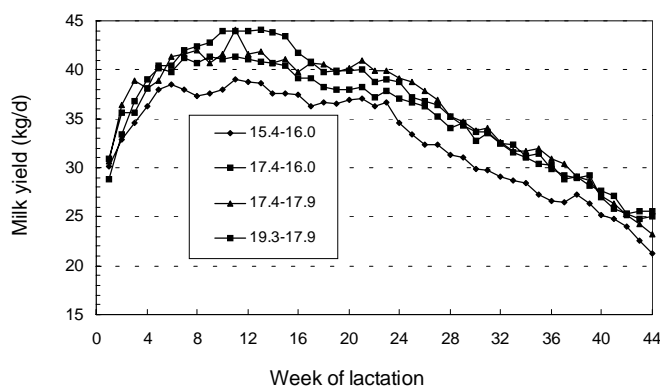


Figure 1. Lactation curves of cows fed diets containing different levels of CP: 15.4% during lactation wk 1 to 16 and 16.0% during wk 17 to 44 (15.4 - 16.0, ○), 17.4% during wk 1 to 16 and 16.0% during wk 17 to 44 (17.4 - 16.0, □), 17.4% during wk 1 to 16 and 17.9% during wk 17 to 44 (17.4 - 17.9, △), and 19.3% during wk 1 to 16 and 17.9% during wk 17 to 44 (19.3 - 17.9, ●).

## Conclusions

Issues related to nutrient management as well as costs associated with excessive protein supplementation point to the need for closer matching of animal requirements with dietary allowance of protein. It is suggested that early lactation diets contain approximately 17.5% CP, 35-37% of which is rumen undegradable. Reduction of dietary protein in later

lactation as milk production declines needs to be done cautiously, and for cows receiving BST and producing approximately 11,000 kg/lactation or more, this reduction should not occur before midlactation, and

then not be reduced to below approximately 16% CP. This recommendation assumes that the supplemental protein offered throughout lactation will have approximately 50% rumen undegraded protein.

Table 1. Ingredients and chemical analysis of diets varying in crude protein content during lactation weeks 1 to 16 and 17 to 44.

Item	wk 1 - 16			wk 17 - 44	
	15.4% CP	17.4% CP	19.3% CP	16.0% CP	17.9% CP
	----- (% of DM) -----				
Alfalfa silage	33.0	33.0	33.0	33.0	33.0
Corn silage	22.0	22.0	22.0	22.0	22.0
HMEC <sup>1</sup> , finely ground	32.0	27.0	22.0	32.6	27.6
Soybeans, roasted	10.0	10.0	10.0	10.0	10.0
Soybean meal, expeller process <sup>2</sup>	...	5.0	10.0	...	5.0
Mineral and vitamin mix	3.0	3.0	3.0	2.4	2.4
Chemical analyses					
CP	15.4	17.4	19.3	16.0	17.9
RUP, % of CP <sup>3</sup>	33.5	35.8	37.6	33.5	35.8
NDF	29.3	29.6	30.0	29.0	29.4
ADF	20.1	20.3	20.5	20.0	20.2
NE <sub>L</sub> , Mcal/kg <sup>3</sup>	1.64	1.64	1.65	1.61	1.61

<sup>1</sup>High moisture ear corn.

<sup>2</sup>Soyplus<sup>®</sup> (West Central Cooperative, Ralston, IA).

<sup>3</sup>Estimated based on feedstuff values (NRC, 1989).

Table 2. Milk yield, intake N, milk N, and manure N of cows fed diets varying in CP content during 308-d lactation.

Item	Treatment <sup>1</sup>				SEM	P*		
	15.4-16.0 (n = 15)	17.4-16.0 (n = 15)	17.4-17.9 (n = 14)	19.3-17.9 (n = 14)		a > b	b > c	a > c
	----- (kg) -----							
Milk	10,056 <sup>c</sup>	10,832 <sup>b</sup>	11,095 <sup>a</sup>	11,132 <sup>a</sup>	349	...	0.12	0.04
3.5% FCM	10,690 <sup>b</sup>	11,628 <sup>a</sup>	11,804 <sup>a</sup>	11,559 <sup>a</sup>	368	...	0.11	0.07
Intake N	177.8 <sup>c</sup>	189.1 <sup>b</sup>	213.7 <sup>a</sup>	214.2 <sup>a</sup>	4.0	0.01	0.05	0.01
Milk N	51.2	48.9 <sup>b</sup>	51.5	53.0 <sup>a</sup>	1.6	0.08	...	...
Manure N <sup>2</sup>	126.6 <sup>c</sup>	140.2 <sup>b</sup>	162.2 <sup>a</sup>	161.2 <sup>a</sup>	3.8	0.01	0.01	0.01

\*Values without superscripts do not differ ( $P > 0.15$ ) from other values within a row.

<sup>1</sup>Treatments varying in dietary CP content: 15.4% during lactation week 1 to 16 and 16.0% during wk 17 to 44 (15.4-16.0), 17.4% during wk 1 to 16 and 16.0% during wk 17 to 44 (17.4-16.0), 17.4% during wk 1 to 16 and 17.9% during wk 17 to 44 (17.4-17.9), and 19.3% during wk 1 to 16 and 17.9% during wk 17 to 44 (19.3-17.9).

<sup>2</sup>Calculated from intake N - milk N, assuming no deposition or mobilization of tissue N.